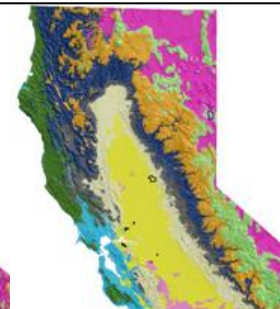
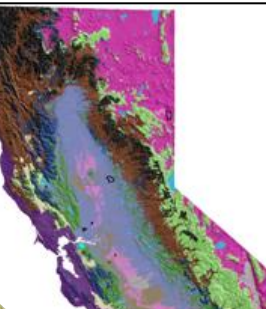
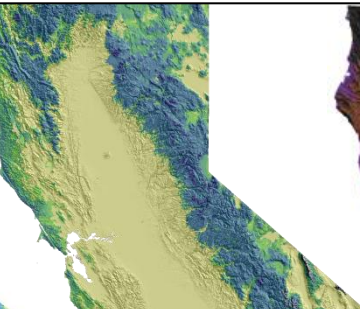
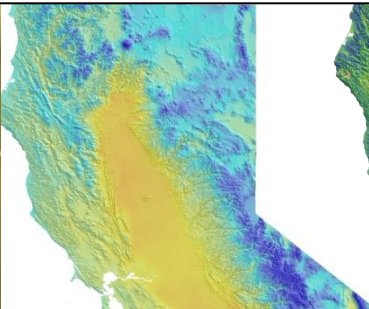




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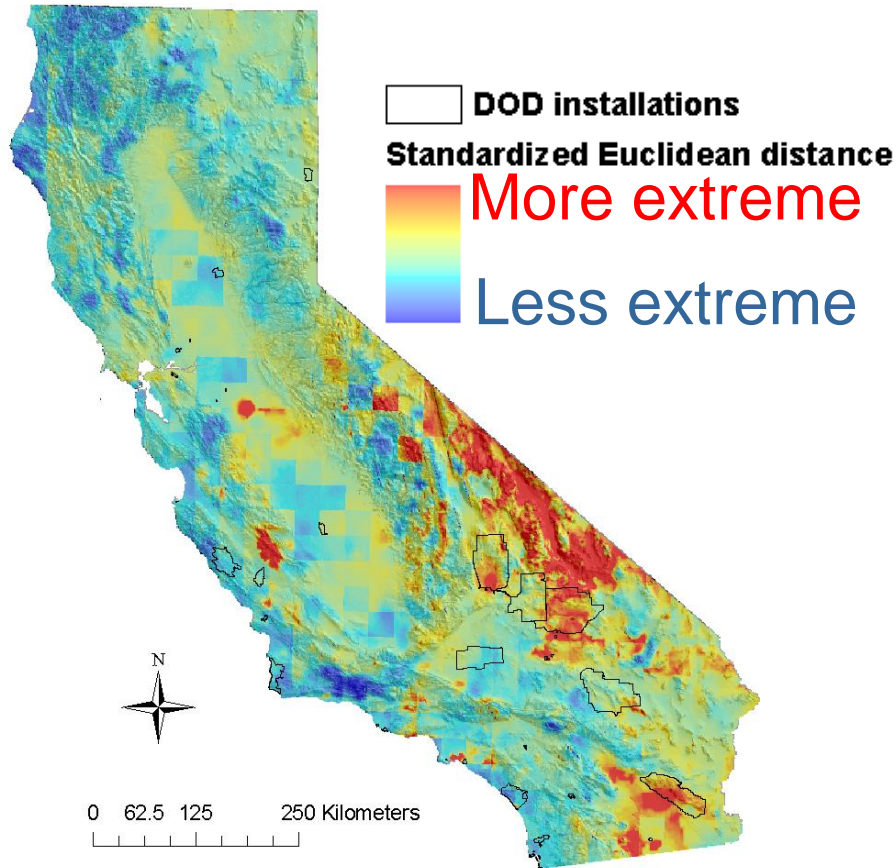


# Using environmental clustering to examine the potential regional effects of climate change on birds on military bases in California

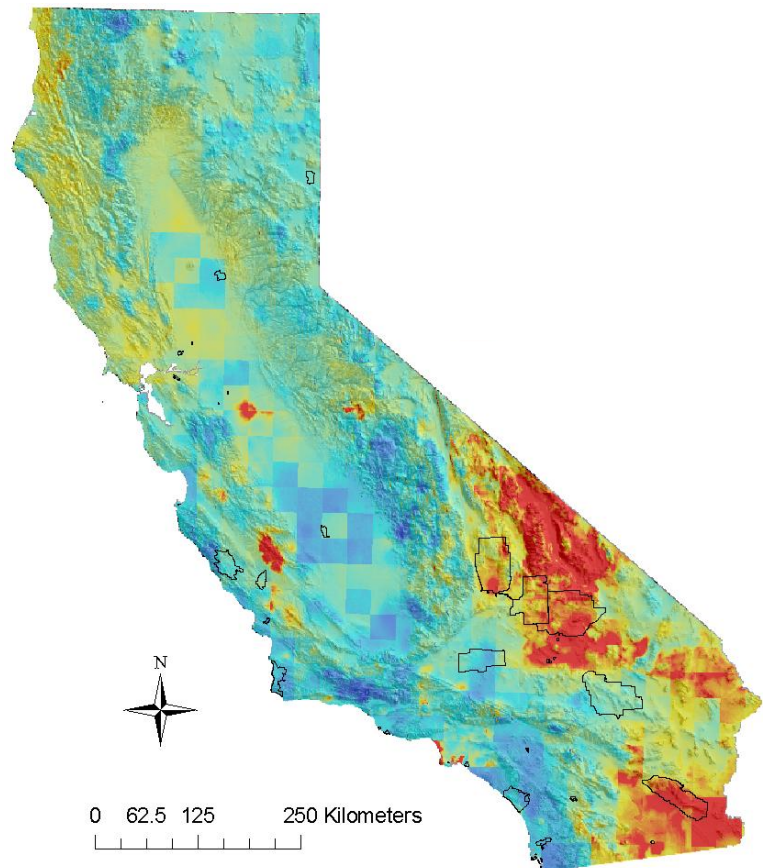
Sam Veloz, Dennis Jongsomjit, John Wiens, Chrissy Howell  
sveloz@prbo.org

# Where will future climate change be most extreme relative to historic variability?

## GFDL A2 2070



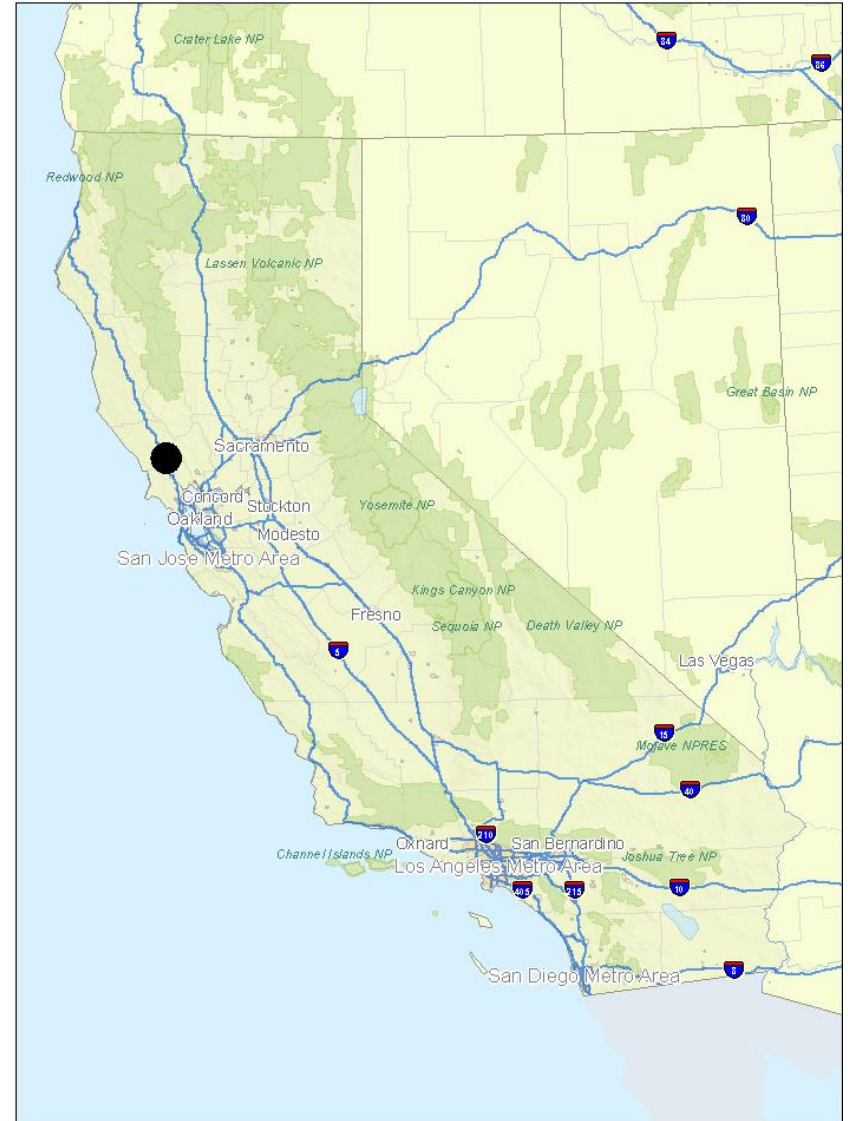
## CCSM A2 2070



<http://data.prbo.org/apps/ecn/>

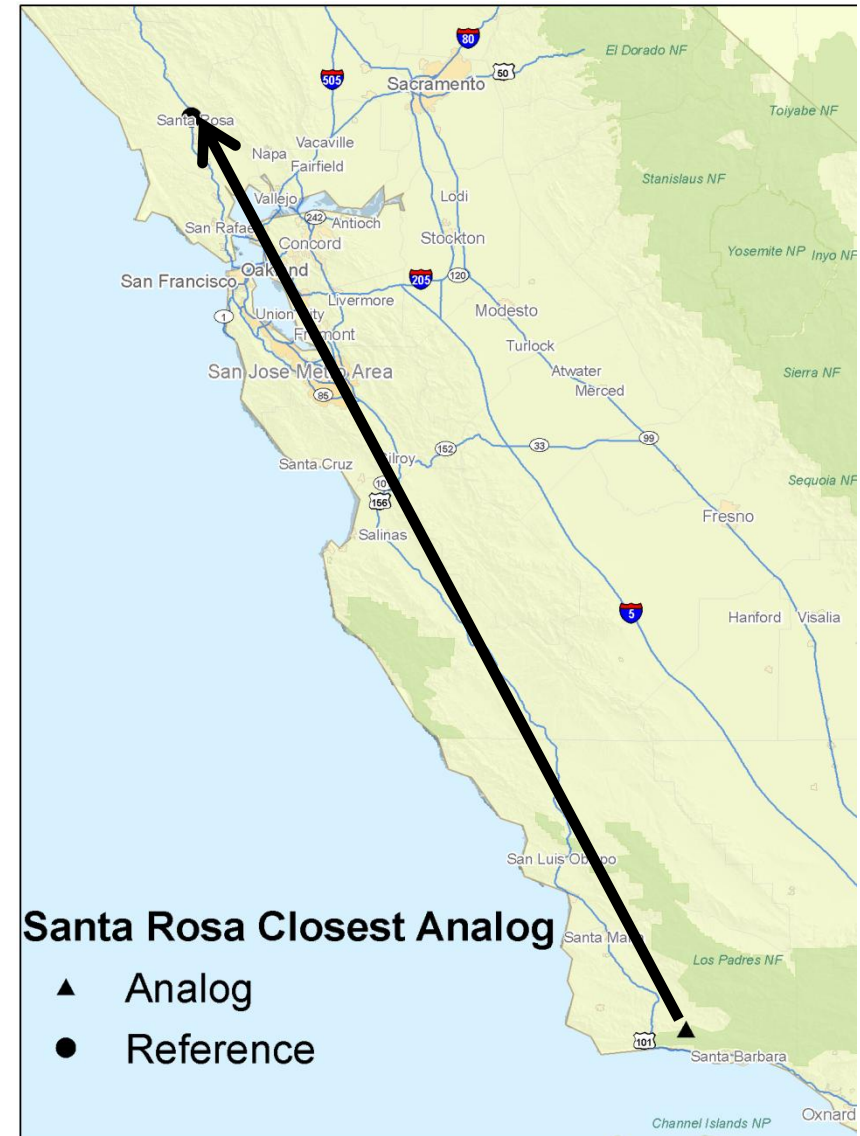
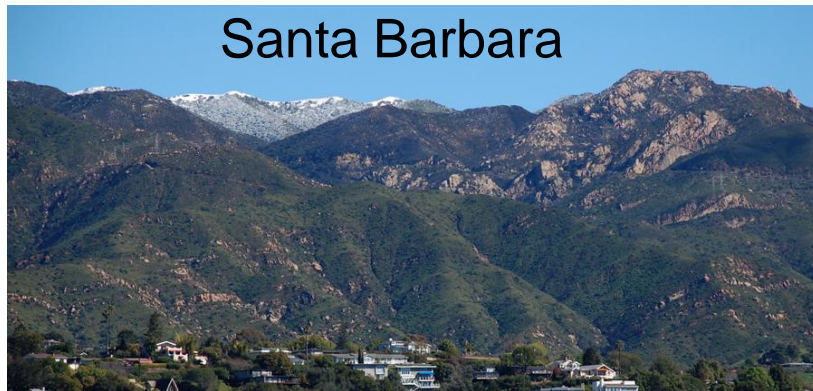
# How big of a difference will projected climate change be?

# What is the best current match for Santa Rosa's future climate at the end of the 21<sup>st</sup> century?



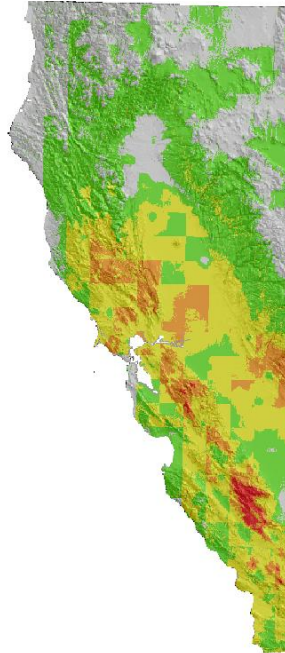
# For a pixel showing moderate to high change relative to historic variability

The best match for Santa Rosa's future climate is like 20<sup>th</sup> century climate inland from Santa Barbara

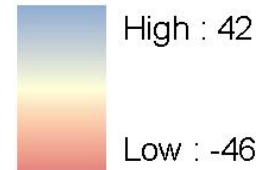


# There may be ecological surprises: Results from models for ~200 avian species

GFDL A



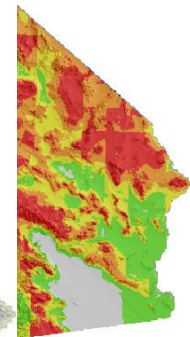
**Future - Current  
Species richness**



70

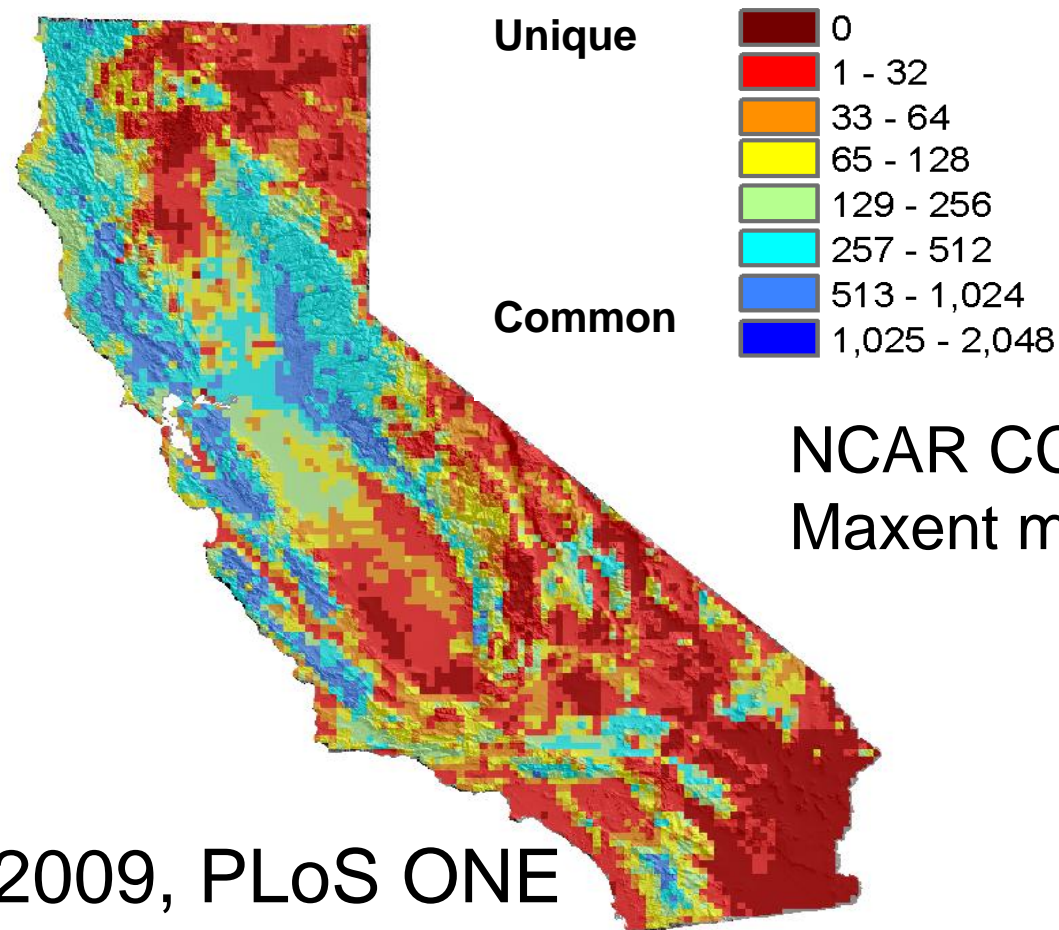
Avian c

urrent



# There may be ecological surprises: Results from models for ~60 avian species

## Future Bird Communities: Number of Modern Analogues



# We will need to adapt resource management to reflect a new world

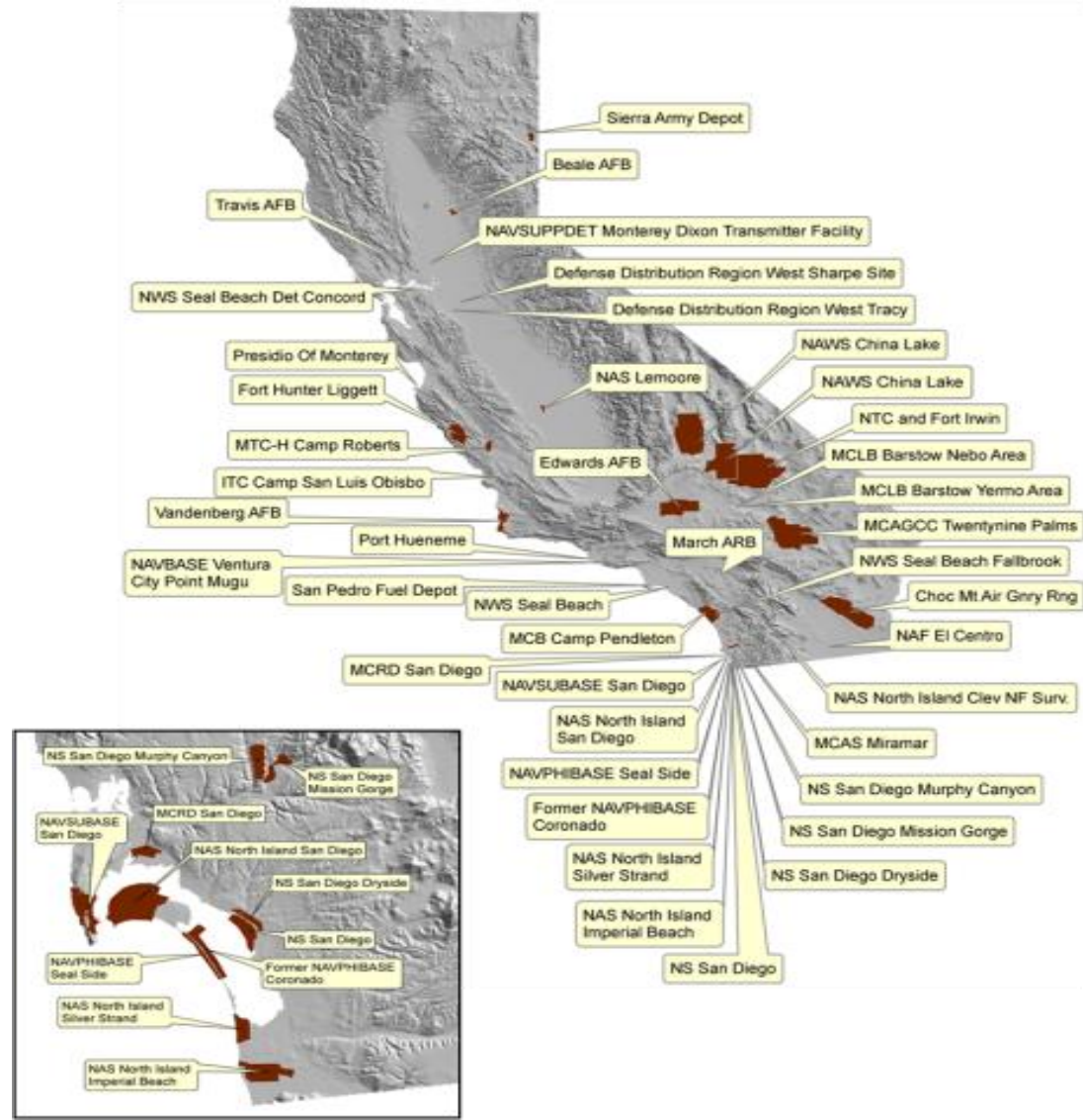
- Species and the areas we manage will be exposed to significant climate change
- Species will respond to these changes, sometimes in unexpected ways.
- Future ecosystems and communities may have no analog in our world today.
- Managers may need to look beyond their administrative boundaries to most effectively conserve biodiversity

# How can management use this information?

## Department of Defense lands as a case study

Can we use our models to suggest where management could be more efficient from a regional perspective?

Can we use boundaries defined by environmental or biological conditions to guide management?

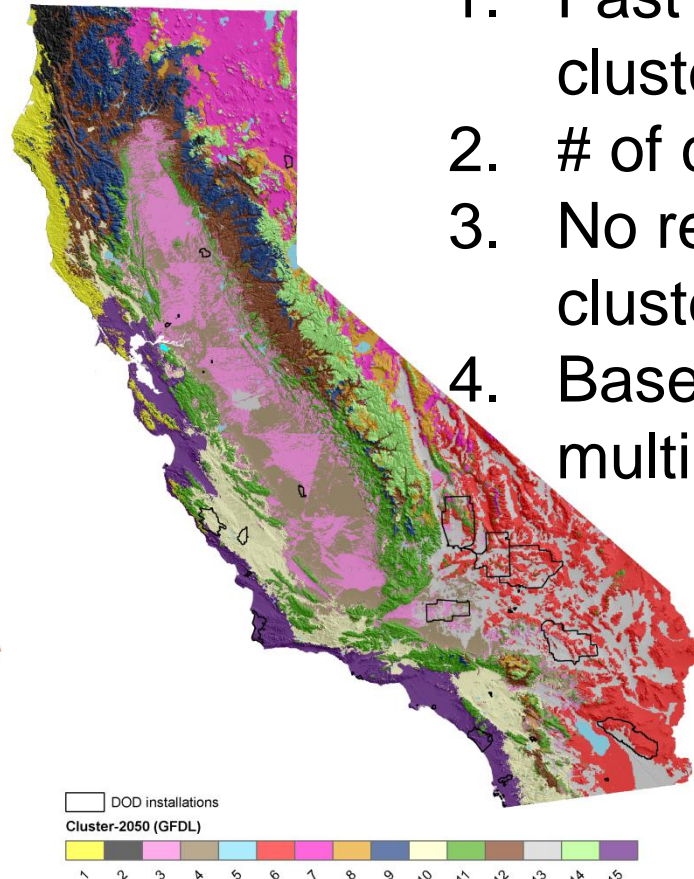


# Kmeans clustering of climate variables, 15 classes

1. Fast efficient way to cluster data
2. # of clusters is arbitrary
3. No relationship of clusters through time
4. Bases are covered by multiple classes

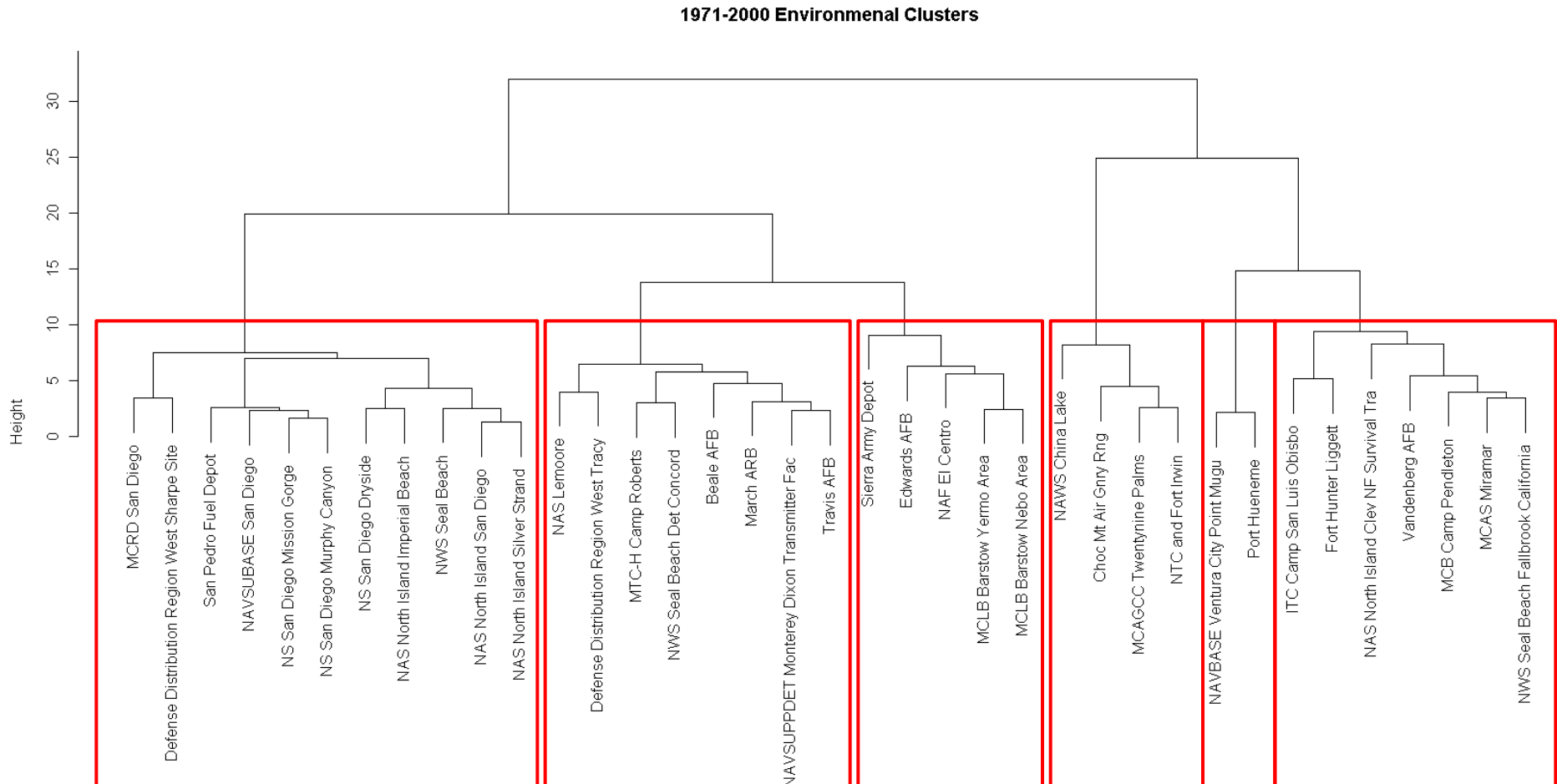


Current

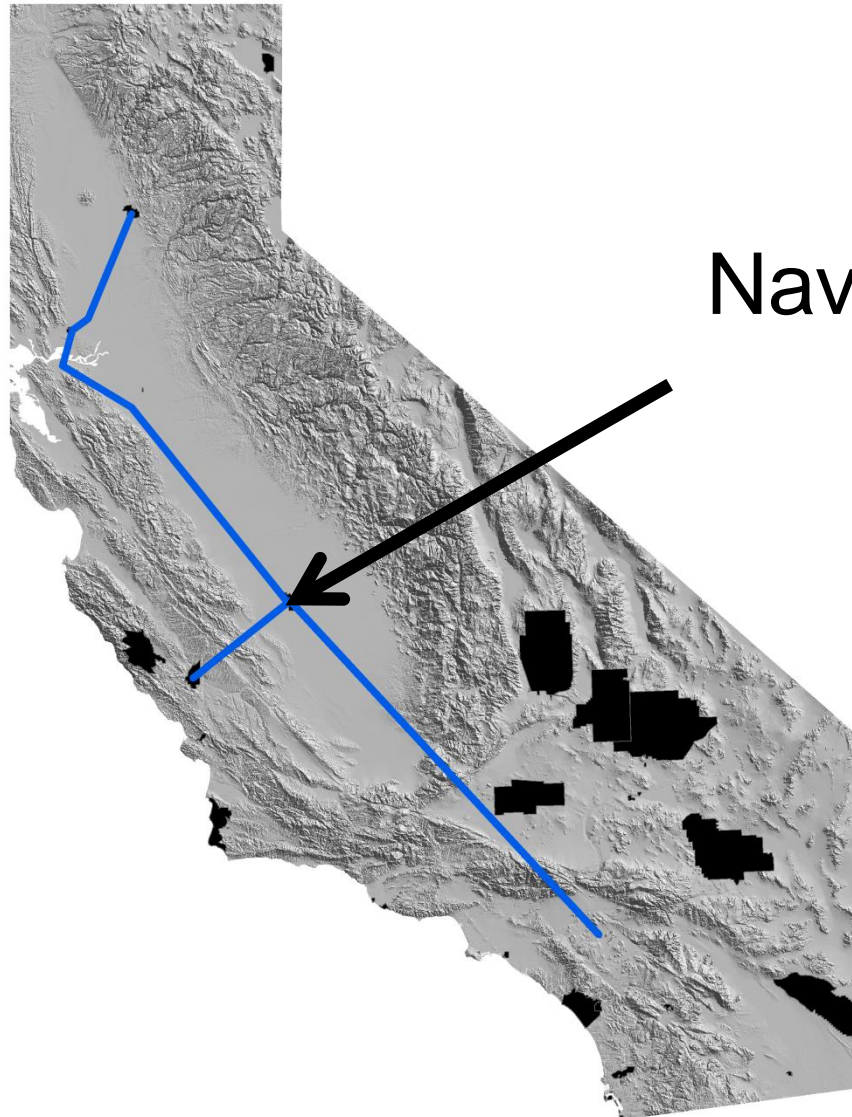


GFDL A2 2070

# Hierarchical clustering: environmental data

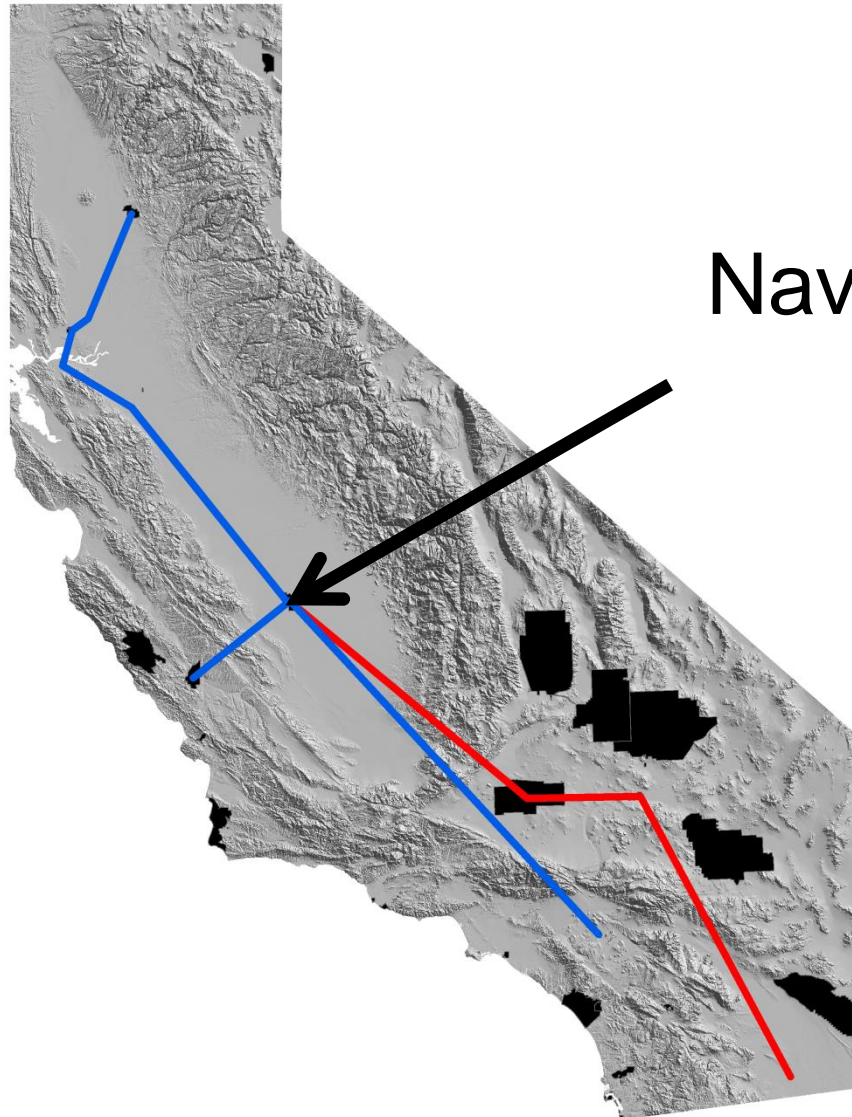


# Classifications change between current/future climate conditions



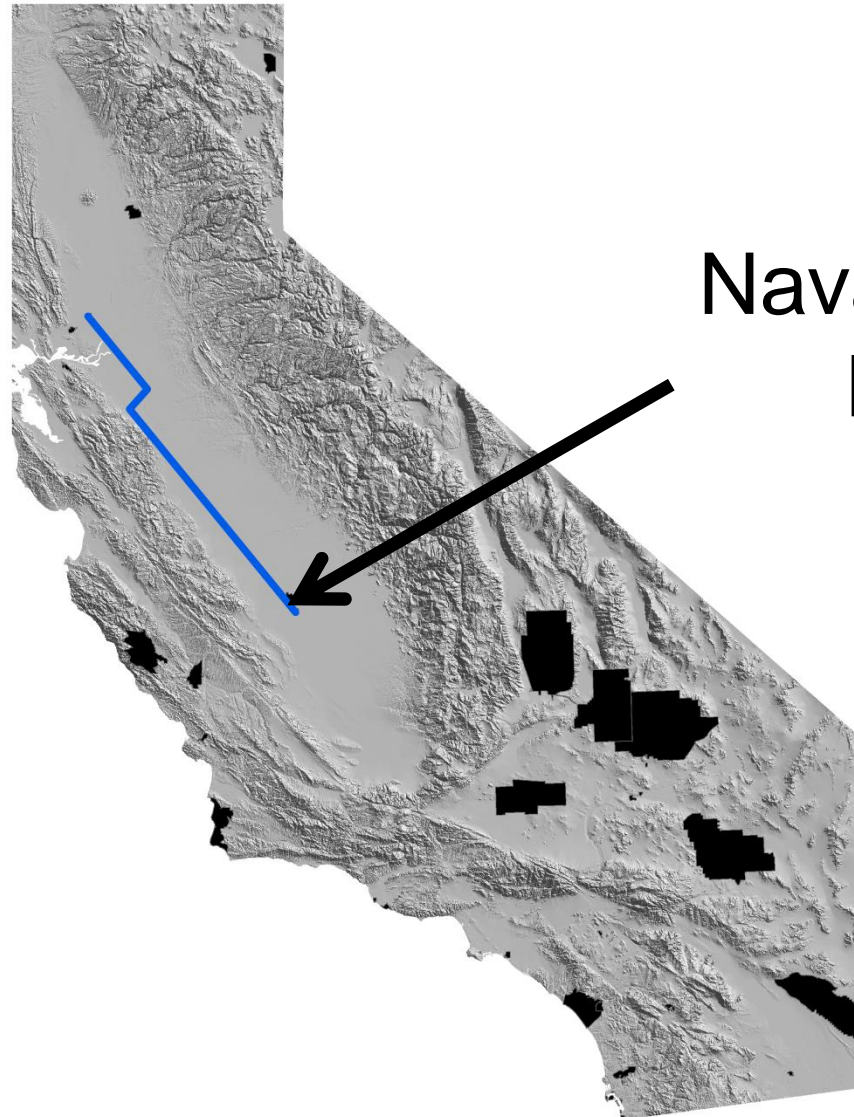
Naval Air Station  
Lemoore

# Classifications change between current/future climate conditions



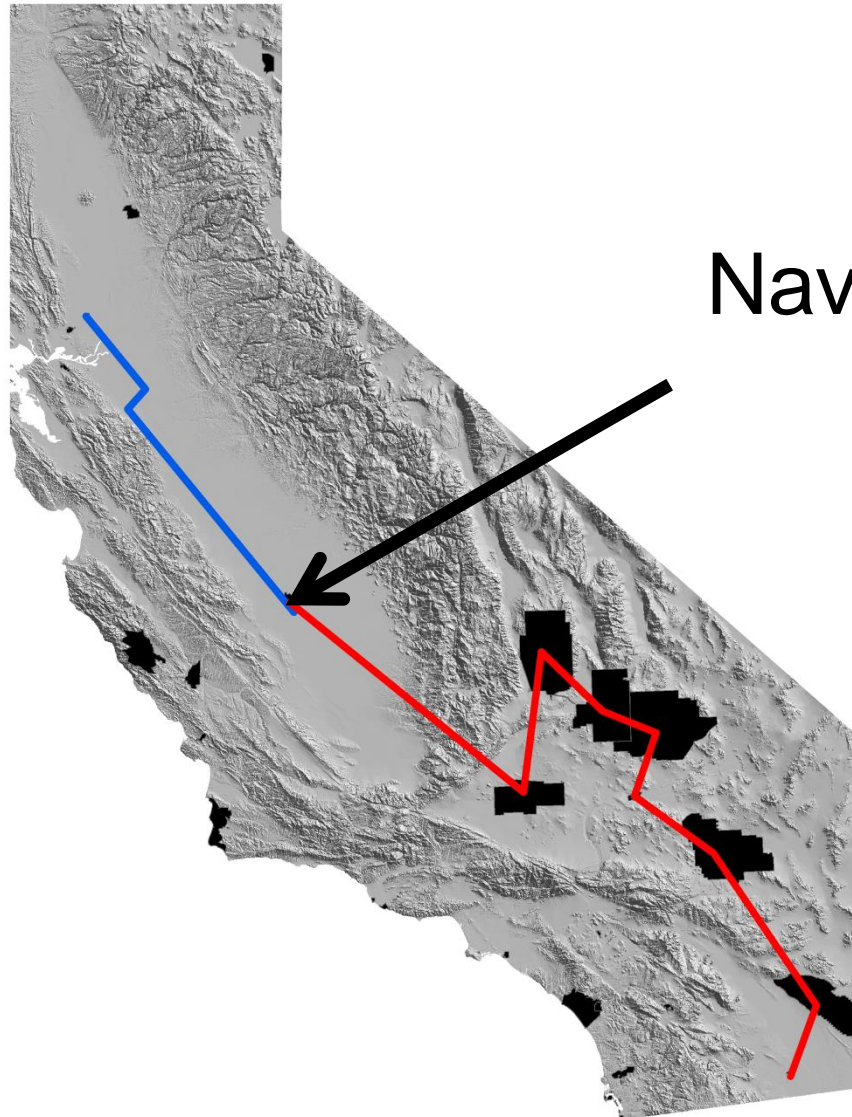
Naval Air Station  
Lemoore

# Similar results using bird distributions but not equivalent



Naval Air Station  
Lemoore

# Similar results using bird distributions but not equivalent



Naval Air Station  
Lemoore

# Conclusions

- Climate change will require adaptation of conservation and resource management strategies to effectively deal with novel conditions.
- Collaboration among administrative units with similar environmental conditions or avian communities could enhance conservation efforts by coordinating actions to most efficiently protect natural resources.

# Acknowledgements

[www.prbo.org/cadc](http://www.prbo.org/cadc)

**Bird Data:** PRBO terrestrial division staff and interns, Klamath Bird Observatory, Redwood Sciences Laboratory (USFS), Breeding Bird Survey (USGS), Cornell Lab of Ornithology,

**California Avian Data Center Website:** M. Fitzgibbon, D. Jongsomjit, D. Moody, PRBO

**Environmental Data:** PRISM Climate Group, California Gap Analysis Project

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# Presentation outline

1. PRBO's work on climate change in CA
2. How can results inform management from a regional perspective?
3. Cluster analysis of climate and birds
4. Department of Defense lands in CA as case study
5. Next steps